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THE WATERS OF NORTH DAKOTA

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THE WATERS OF NORTH DAKOTA

At various times numerous calls have been received in the Public Health Laboratory for data upon that very interesting subject the water supply of North Dakota. An immense amount of material has been accumulated during the period these laboratories have been in operation. Perhaps the most work was done by Dr. Gustav F. Ruediger during his term of office as Director of laboratories and the material he collected has been used, together with a great deal of data accumulated since, in the preparation of this paper.

The rivers of the State contain a palatable water and need very little treatment to render them quite safe for drinking purposes, but most of them are very hard. Such cannot be said of the well waters. Throughout the whole of the State, shallow wells, none deeper than 20 feet, yield a fairly palatable water, but artesian wells and deep wells as a rule yield a highly mineralised water. In order to find a standard with which to compare the waters of this state and decide which is a good water and which is the opposite, the standard fixed by the Secretary of the Treasury for the chemical purity of waters used on interstate trains has been adopted. The amounts are expressed in parts per million and can be converted into grains per gallon by multiplying by 0.058:—

	Good	Fair	Poor	Bad
Total Solids	up to 1000	up to 1500	up to 2000	
Chlorine	" " 250	" " 800	" " 1200	
Sulphate Radicle	" " 250	" " 600	" " 1000	anything
Magnesium	" " 75	" " 125	" " 175	over
Carbonates	" " 50	" " 100	" " 250	these
Alkalinity	" " 500	" " 800	" " 1200	figures

Many of the waters placed in the "fair" class or in the "poor" class have but a temporary effect upon the people using them and the body soon develops a tolerance for them. Stock which has been reared on such water is slow to drink water which is in the "good" class. At the same time, however, horses are said to suffer various disorders when subjected to waters with high chlorine and sulphate content. When selecting a water for municipal supply every effort should be made to find one that meets all requirements for the class called "good" and does not have a hardness exceeding 400 parts per million. Its bacterial content should also be considered, for, while the water may pass muster chemically, if it be above standard bacteriologically, the cost of treatment has to be considered.

The suitability of a water for boiler use has also to be considered and it has been found that there are no good, untreated, boiler waters in the state, the proportion of lime, magnesium or iron being so high that the formation of in-

crustants renders them very unsuitable. For this reason the Great Northern has installed water softening plants throughout its lines from Devils Lake west.

The artesian wells in the Red River Valley yield water that is quite salty to taste and very hard. Practically every water analyzed contains more than 2000 parts per million of total solids and over 1200 parts of chlorine. These waters are used for every purpose, apparently without bad effects. The deep wells which do not flow, often contain very good water especially in Cass and Richland County.

The shallow well water of the Red River Valley is, as a rule, less highly impregnated with mineral salts than in the deep wells, except perhaps, in the northern part of the state, where throughout, Pembina, Cavalier, Walsh and again in Trail counties the underground shallow wells are quite salty in taste. If the soil is sandy the waters may have a hardness of 500 parts or less but their bacterial count is likely to be high, especially if the wells are not properly protected. The shallow well waters classed as "bad", contain large amounts of epsom salts which give the water a bitter taste and are irritating to the intestine.

The deep well waters in the central plains are somewhat better than those in the Red River Valley being lower in solids, hardness, and sulphates but higher in alkalinity, but even at that, they are considerably above what is considered a suitable water. The flowing wells are not very common except in the southern tier of counties. The wells here are very deep and the waters highly mineralised and uniformly hard. All are very high in sulphate or chlorides, The shallow wells of this region are softer and lower in magnesium compounds than those of Red River valley, but when compared with the deep well waters they are harder and higher in magnesium salts. The best shallow wells are found in Pierce, Benson and Nelson counties.

In the western part of the state or Missouri plateau region flowing wells are very scarce except at the north and south borders of the State. These waters are very soft but have a high alkalinity due to bicarbonates. The deep well waters are also high in alkalinity and have a high mineral content and can be used with some satisfaction as boiler supply.

Compared with the deep well waters of the Red River valley they have a higher alkalinity and are more highly mineralised but have not such a great degree of hardness. Compared with those in the central part of the state they have a higher alkalinity and hardness content but not so much chlorine or sulphates.

The shallow wells in this part of the state are the least mineralised of anywhere and for this reason can be classed as good boiler waters.

To go into the subject a little more particularly, the records of chemical analyses made at the main office of the Public Health Laboratories have been gone over and the results of 96 examinations made from January 1, 1917 to February 14, 1920 have been analysed.

The principal visible water supply of the Red River valley is the Red River, this source is used by Wahpeton and Fargo and is used as an auxiliary supply for Grand Forks. The water, owing to its hardness, turbidity and high pollution is softened, sedimented and chlorinated. The Fargo analysis may be taken as an example:

Total solids	179
Alkalinity	113
Chlorine	7
Sulphates	31
Carbonate	32
Magnesium	97

Comparison with our standard shows that this water contains too high a hardness radicle. It is interesting to compare also the water of the Goose river used by Mayville:

Total solids	918
Alkalinity	251
Chlorine	26
Sulphates	390
Carbonates	251
Magnesium	390

This water owing to its high mineral content is practically unfit for any purpose whatever, even plumbing fixtures are attacked.

Nine well waters of varying depths have been examined, these have been scattered throughout this region. It is difficult to single out any one as distinctive for the region as they vary so much in total solids and chlorine content not to mention the hardness. However, I'll give the figures for a well at Drayton:

Total solids	20922
Alkalinity	236
Chlorine	9384
Sulphates	988
Carbonates	23
Magnesium	256

and the well in the park at Mayville:

Total solids	3362.
Alkalinity	219.3
Chlorine	773.7
Sulphates	649.8
Carbonates	568.6
Magnesium	281.2

All these waters are high in sulphates, alkalinity and magnesium compounds. They have more or less of a "salty" taste and are high in incrustants.

Of waters from the central plains some 18 localities have contributed 38 samples. These are all well waters, many being taken from several sources in one locality in an endeavor to find the most suitable supply for a waterworks installation. The latter samples being from Jamestown, Langdon, Lakota, Leeds, Fessenden, and New Rockford which you will see furnish rather a good selection for comparison. A study of the average analysis of 4 samples of Jamestown water taken from different wells shows the following:

Total solids	754.
Alkalinity	359.
Chlorine	42.
Sulphates	421.
Carbonates	105.8
Magnesium	179.2

Comparing this with our standard we see that the mineral content puts these samples in the "fair" class if not in the "poor". Going to the opposite end of the State we may examine the Langdon waters where some 10 samples were examined to determine which would yield the most suitable water for a city supply. The average of the analysis is as follows:

Total solids	1157.
Alkalinity	266.5
Chlorine	177.8
Sulphates	379.6
Carbonates	132.8
Magnesium	80.2

Comparison with our table shows this to be a fairly good water. In fact the water in use now at Langdon is of good quality but contains enough iron to cause a noticeable taste and odor when it stands in the pipes or is heated.

It might also be interesting in this connection to consider the water as found at Fessenden which is placed in about the centre of this section of the State. In searching for a satisfactory water supply for this city five representative samples were examined. These when studied yielded results as follows:

Total solids	1342.
Alkalinity	540.5
Chlorine	182.3
Sulphates	340.3
Carbonates	284.2
Magnesium	51.2

The waters from this region therefore can be placed in the "good" class except that they need softening. It is difficult however to say positively just how each of the many samples in this region compare with each other but it may be stated that the northern group of waters, while very "salty" in taste, and so unfit for drinking, are often quite soft.

In the Missouri Plateau section beside some 24 wells we

should also consider the Missouri river which is used by Williston, Mandan and Bismarck. The water from this source is very turbid and highly polluted so that these cities have installed complete treatment plants, such as sedimentation, chemical treatment, filtration, except Bismarck and Mandan, and chlorination. The untreated river water in several examinations taken at Williston and Bismarck usually tests as follows:

Total Solids	662
Alkalinity	368
Chlorine	29
Sulphates	161
Carbonates	125
Magnesium	164

This shows that the river water is of moderate hardness and can be made a very suitable source of supply.

The well waters of this region are more or less colored with vegetable matter owing to the whole district being underlayed with lignite deposit, several of the wells yield a coal black water which, when treated with a coagulant, is quite satisfactory. Such a water is found at Scranton in Bowman County in the southwest corner of the State. Seven samples of varying duskiness have been analysed from this town with results as follows:

Total solids	1253.
Alkalinity	453.1
Chlorine	22.4
Sulphates	417.8
Carbonates	318.
Magnesium	157.1

Which places these waters in the "fair" column but shows them inclined to be hard.

The waters in the northern part of this section should next be considered and these comprise samples from Crosby, Berthold, Minot, Kenmare and Stanley. Synopsised these analyses are as follows:

Total solids	2147.1
Alkalinity	709.7
Chlorine	38.4
Sulphates	625.2
Carbonates	625.3
Magnesium	142.1

You will notice that it may be said that these waters come in the "poor" class which is all too true with the exception, perhaps, of Minot. Here we have a water that, while it has some color and a pleasantly salty taste, is of very good quality otherwise and one of the two city wells is quite "soft". All these samples contains iron in such quantities as to stain porcelain or enamel ware.

This report would not be complete without reference being made to the spring waters. These are located in Grand

Forks, Trail and Stutsman counties together with a group along the Missouri slope seven samples in all. Springs occur in three localities in Grand Forks county, Inkster, Northwood, Hatton with perhaps one exception, yield a very good sample of water from a chemical standpoint. The spring near New Rockford and at Jamestown also yield excellent water.

Three springs near Williston, recently examined, are found to be also in the "good" class.

The Federal Government is conducting an investigation into the question of "stream pollution" and on the receipt of a request from Mr. R. E. Tarbett, Associate Sanitary Engineer, United States Public Health Service a questionaire was sent out to all the cities and towns in the State possessing water and sewer systems to ascertain what disposal was made of sewage in this state. Replies were received from thirty-six points, these have been arranged according to the following table:

PLACE	Population	Water System	Source Supply	Treated	Stand Pipe	Direct Pumpage	Gal. used per day in thousands	Sewer System	Storm Sewer Separate	Sewage Treated	Method		% Population Served
Anamoose	700	Yes	Well	No	Yes	Yes	10	Yes	No	No	——		32
Bismarck	7161	Yes	River	Yes	No	Yes	500	Yes	No	No	——	**	50
Carrington	1500	Yes	Well	No	Yes	Yes	?	Yes	Yes	Yes	Septic tank		60
Devils Lake	5200	Yes	Well 7	No	Yes	Yes	250	Yes	No	Yes	Septic tank	**	50
Dickinson	4100	Yes	Wells	No	Yes	Yes	175	Yes	No	Yes	Septic tank	**	65
Enderlin	1919	Yes	Wells 3	No	Yes	gravity	50	Yes	No	Yes	Septic tank	**	65
Fargo	23000	Yes	River	Yes	No	Yes	2300	Yes	No	No	——	**	90
Grand Forks	14000	Yes	River	Yes	No	Yes	890	Yes	No	No	——	**	90
Grafton	2500	Yes	Well 2	No	Yes	Yes	?	Yes	No	Yes	Septic tank		75
Garrison	714	Yes	Wells	No	Yes	Yes	?	Yes	No	No	——	**	83
Hillsboro	1183	Yes	Well	No	Yes	Yes	6	Yes	No	No	——	**	50
Hazen	600	Yes	Well	No	Yes	Yes	?	Yes	Yes	Yes	Chemical	**	10

* Not used for drinking.

** Discharge into river, wet coulee or lake.

PLACE	Population	Water System	Source Supply	Treated	Stand Pipe	Direct Pumpage	Gal. used per day In Thousands	Sewer System	Storm Sewer Separate	Sewage Treated	Method		% Population Served
Harvey	1492	Yes	River	No	Yes	Yes	60	Yes	No	No	——	**	*25
Jamestown	6627	Yes	Well	No	Yes	Yes	450	Yes	No	Yes	Septic tank	**	75
Kenmare	1543	Yes	Well	No	Yes	Yes	?	Yes	No	No	——	**	60
Larimore	1039	Yes	Well	No	Yes	Yes	?	Yes	No	No	——	**	30
Lidgerwood	1100	Yes	6 Wells	No	No	Yes	?	Yes	No	Yes	Septic tank	**	100
Langdon	1228	Yes	2 Wells	No	Yes	Yes	20	Yes	No	No	——	**	75
LaMoure	1009	Yes	Well	No	Yes	Yes	50	Yes	No	No	——	**	95
Lisbon	1655	Yes	5 Wells	No	Yes	Yes	30	Yes	No	No	——	**	80
Mayville	1218	Yes	River	No	Yes	Yes	70	Yes	No	Yes	Cess pool	**	*50
Marmarth	1460	Yes	2 Wells	No	Yes	Yes	20	Yes	No	No	—— *	**	*65
Mandan	3873	Yes	River	Yes	No	No	133	Yes	Yes	No	——	**	75
Minot	12000	Yes	2 Wells	No	Yes	Yes	300	Yes	Yes	Yes	Filter Beds	**	80

* Not used for drinking.

** Discharge into river, wet coulee or lake.

PLACE	Population	Water System	Source Supply	Treated	Stand Pipe	Direct Pumpage	Gal. used per day in thousands	Sewer System	Storm Sewer Separate	Sewage Treated	Method		% Population Served
New Rockford	2200	Yes	4 Wells	softened only	Yes	No	50	Yes	No	Yes	Septic tank	**	40
Oakes	1637	Yes	18 Wells	No	No	Yes	166	Yes	No	No	——	**	95?
Stanley	591	Yes	2 Wells	No	Yes	Yes	5	Yes	Yes	No	——	**	40
Velva	835	Yes	Springs	No	Reservoir	Yes	30	Yes	No	No	——	**	80
Valley City	5136	Yes	Well	No	Yes	Yes	265	Yes	No	No	——	**	85
Williston	4278	Yes	River	Yes	Yes	Yes	?	Yes	No	No	——	**	98
Wilton	1026	Yes	4 Wells	No	Yes	Yes	25	Yes	No	No	——		25
Wahpeton	3000	Yes	River	Yes	Yes	Yes	300	Yes	No	No	——	**	100
Cooperstown	1019	Yes	Well	No	Yes	Yes	?	Yes	No	Yes	Septic tank		Just completed.
Hankinson	1503	Yes	2 Wells	No	Yes	Yes	?	Yes	No	Yes	Septic tank		Under construction.
Leeds	682	Yes	Well	No	Yes	Yes	10	Yes					*Just completed.
McVille	350	Yes	Well	No	Yes	Yes	10	Yes	No	Yes	Septic tank	**	Just completed.

* Not used for drinking.

** Discharge into river, wet coulee or lake.

Study of this table shows but nine places which get their water from a visible source, eight being rivers and one springs. Six of the eight river supplies are treated with a coagulant and chlorine, the other two use the water for sanitary purposes only. Water for drinking, washing clothes and cooking being obtained from melted ice, cisterns or shallow wells.

In regard to sewage disposal, 27 discharge their sewage into a river, lake or coulee untreated, 9 give a preliminary treatment with some form of septic tank. But one city in the state, as yet, that is Minot, has installed a modern sewage treatment plant and this is expected to be in operation in the summer of 1921. The other places discharge into a low place or dry coulee.

Some attempt is made to soften the river water in Fargo and Grand Forks, New Rockford has just installed a softener for its well water supply and Mayville is considering such an improvement.

In conclusion it may be said that, while some attempt is made to prevent stream pollution, our larger cities, except one, are doing nothing in that respect and it will be only a matter of time before they will be compelled by law to abate the nuisance which their untreated sewage will create for communities situated below them.

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FREE BULLETIN FOR CITIZENS

1. State Public Health Laboratory. History, Instructions and Fee table.
*2. What You Should Know About Tuberculosis.
3. Pure Water and How to Obtain It.
*4. Sporotrichoisis in North Dakota.
*5. Facts about Rabies.
6. The Production and Care of Milk for Infant Feeding.
*7. Facts about Cancer.
8. The Fly; a disease carrier.
9. Ninth Annual Report of State Public Health Laboratories.
10. The Sanitary Privy.
11. Your Baby, How to Keep it Well.
12. The Next Step towards Efficiency in Public Health.
13. Fresh Air and Why. A talk on school room ventilation.
14. Colds. Cause, prevention and home treatment.
15. Cerebro spinal meningitis.
16. Keeping in Repair. How to care for the body—Physical examinations.
17. Scarlet Fever. How it may be detected. How it may be avoided. Directions to mothers, nurses, physicians and health officers for treating cases of this disease.
18. Disinfection and Disinfectants.
19. The Teacher and Communicable Diseases. Symptoms by which teachers may detect these diseases.
20. Diptheria. Cause, prevention and cure.
21. Typhoid Fever. Information for those who care for patient, for physician and health officers in regard to the spread and prevention of typhoid fever.
22. Measles and Whooping Cough. Information for parents and for those who care for the patient, for physicians and health officers in regard to spread and prevention of measles and whooping cough.
23. Smallpox. How to detect this loathsome disease. How the disease spreads, and how it may be avoided. Direction for care of patients.
24. The Wasserman Reaction as a diagnostic procedure. Interpretation. Need for a history. Provocative Wasserman.
25. Health Officer's Loan Library.
26. Stereoptican Loan Library.
*27. Rural Home Comforts. A series of four blue prints together with specifications dealing with the subject of septic tank and sewage disposal.
28. Influenza.
29. The Waters of North Dakota.

* Not in print.